Space Weather Technical Forecast

Issued on Sunday, 27 March 2022 at 13:11 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of G1/Minor Storm intervals days 1 & 2 (27th & 28th). Chance of M-class flares throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low with a single C2 flare from the southeast limb at 26/1540UTC. There are currently 4 sunspot regions on the visible disc. The two largest and most complex regions are in the northeast quadrant, and both have shown signs of development over the past 12-24 hours. AR2975, has increased in extent and now appears to be in a Beta-Gamma formation. Whilst AR2976 has also increased in complexity, with a negative spot developing in the large area of penumbra of the leading group. It is now classified as Eko/Beta-Gamma-Delta. The much smaller group AR2974 Axx/Alpha (which produced the M1 flare on 25th) has been inactive and continued to decline. A new region has developed to the northwest of 2975, and is currently classified Bxo/Beta.
No Earth directed CMEs have been observed, though a CME is visible from the northwest in Lasco imagery from 27/2230 UTC. However, STEREO-A imagery indicates this is likely to be from the far side. A glancing blow remains possible from a coronal mass ejection originating on the 25th.

Solar Wind / Geomagnetic Activity: The solar wind as observed by DSCOVR at L1 indicated the arrival of a positive coronal hole high speed stream. Solar wind speeds were generally stable between 400 and 450 km/s, but rose from 27/0500 UTC to around 500-550 km/s. The density was around average until 26/1430 UTC, when it rose above average (10-20 ppcc). The strength of the interplanetary magnetic field (IMF), Bt, was mostly weak (<8 nT) but has risen to moderate (8-15 nT) levels at times from 26/1830 UTC. The north south component Bz strengthened, ranging -7 to +12 nT, with a largely positive orientation. The Phi angle was predominately positive (away from the Sun), but with brief transitions to negative. Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) measured at GOES 16 was at Background levels. The high energy electron flux (greater than 2MeV) has been predominantly at Background levels, but reached Moderate levels during the diurnal peak. The corresponding 24-hour integrated electron fluence was stable and well below the Active (1e8 integrated pfu) threshold, with the observed fluence at 27/0000 UTC 2.91e6 integrated pfu.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to be Low, with further C-class flares expected. There is a chance of activity increasing to Moderate levels, with isolated M-class flares.

Solar Wind / Geomagnetic Activity: A glancing impact is likely later on the 27th into the 28th from the CME which left the Sun on the 25th March. Otherwise, solar winds are expected to be

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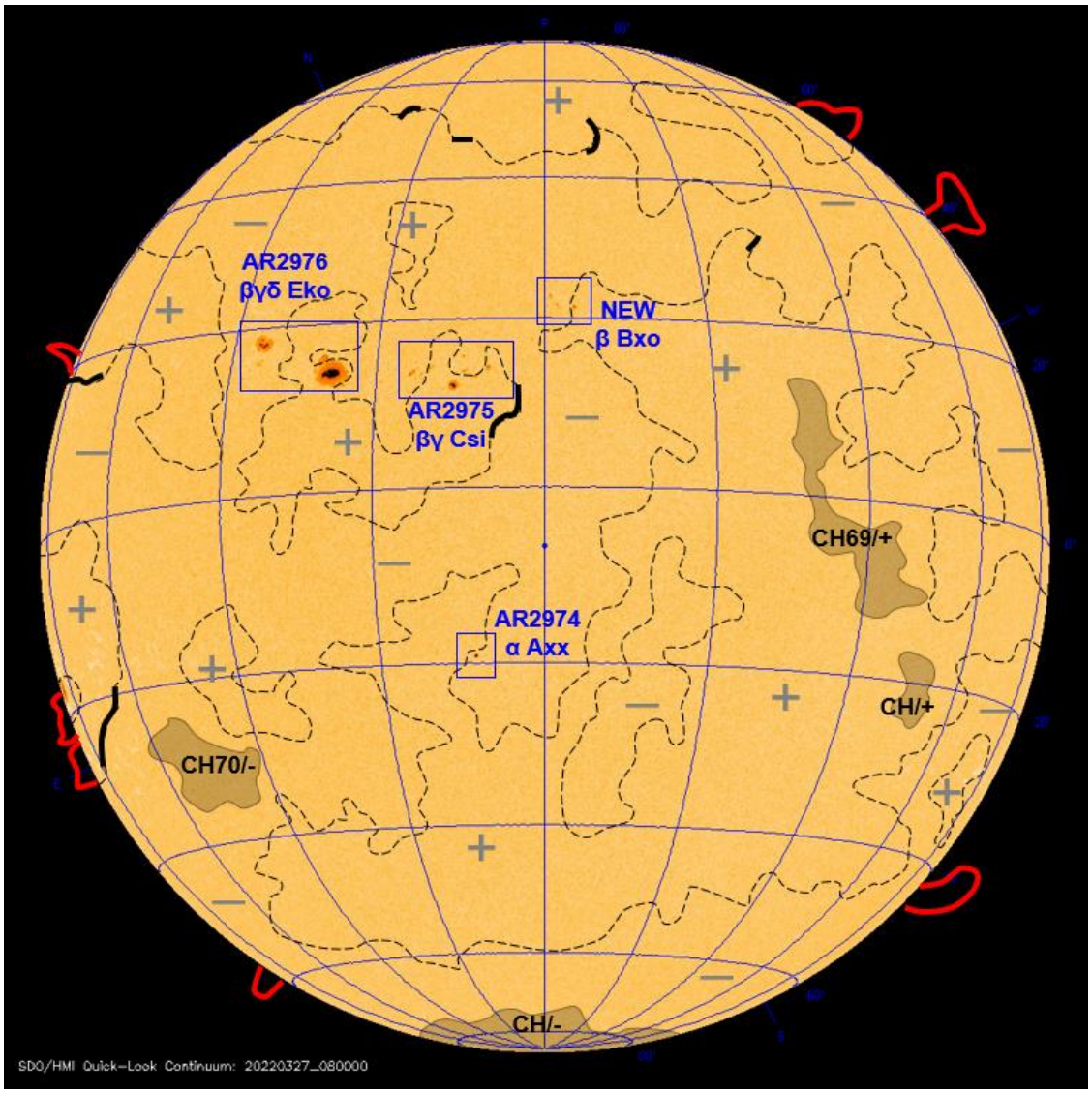
elevated until day 3 (29th) due to the fast wind from CH69/+. Quiet to Unsettled geomagnetic activity will occasionally become Active during days 1 and 2 (27th and 28th), with G1/Minor Storm intervals possible from the potential CME arrival. Geomagnetic activity is expected to become predominantly Quiet through day 3 (29th).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to be at Background levels throughout the forecast period, with only a very slight chance of rising above background levels through the period. The high energy (greater than 2 MeV) electron flux is currently at background, with a chance of rising to Moderate to High in response to the fast wind of CH69, but with a likely period of drop out with the CME arrival either late 27th or early 28th. The associated 24 hr fluence will likely persist below the Active (1e8 integrated pfu) threshold but with a chance of rising above day 3 or 4 (29th or 30th).

Figure 1. Solar Analysis Valid 27/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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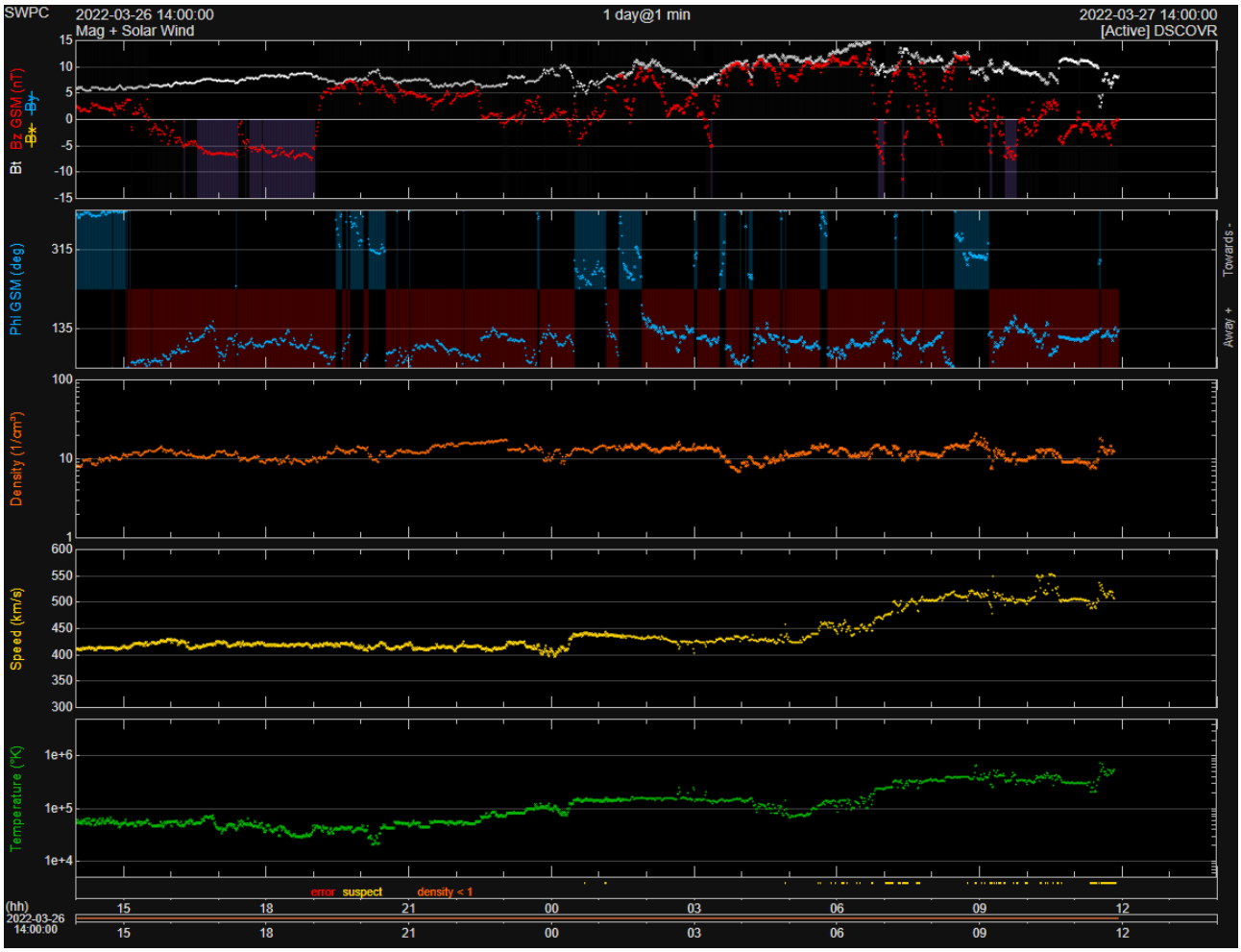
Figure 2: 24 hour solar wind as observed by DSCOVR at L1



Geomagnetic Storms:

There is a CME which has the potential for a glancing impact at Earth, from the M1.5-flare of AR2974 on the 25th. There is some notable uncertainty with the timing of this CME, and extent of impact, due to a difficult assessment on the westward extent of the CME in available imagery. Current expected arrival time is 27/2300 UTC +/- 10 hours.

Solar winds are currently elevated, due to the high speed stream from CH69/+. They are expected to remain elevated until day 3 (29th), when they will gradually decline towards ambient levels as the effects of the coronal hole wane. This is in-line with observations at STEREO A and is supported by Enlil. Additional enhancement could be provided later on day 1 into day 2 (27th/28th) due to the potential arrival of the CME mentioned above.

Quiet to Unsettled geomagnetic activity will occasionally become Active during days 1 and 2 (27th and 28th), with G1/Minor Storm intervals possible from the potential CME arrival. Geomagnetic activity is expected to become predominantly Quiet through day 3 (29th) and continue into day 4 (30th).

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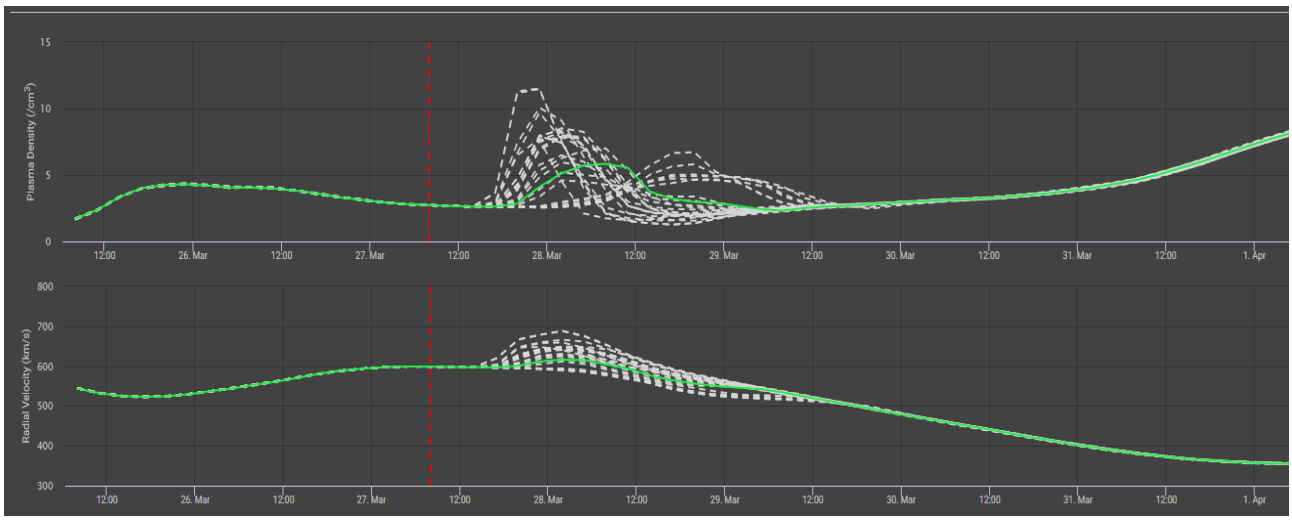
Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	40	60	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
26/0904 UTC	Full Halo	M flare	SE	560 km/s	27/2300 +/- 10hrs	Glancing blow likely

Figure 3: Enlil ensemble, showing potential arrival of CME.



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Radio Blackouts - X-Ray Flares:

Solar activity is currently Low. It is expected to remain Low throughout much of the period, with C-class flares expected. However, there is a chance activity may increase to Moderate levels, with isolated M-class flares. Currently the most likely source of this is AR2975 and AR2976, in the northeast quadrant, which have increased in complexity over the past 24 hours, and are in Beta-Gamma formation. AR2976 also appears to have a Delta spot. There are two other sunspot regions on the visible disc, but they are both small and simple and pose little flare risk at this stage. A new region is currently emerging round the southeast limb, and this will need to be analysed as it comes into view to assess it's flare risk, but it is likely that this region was the source of the C2 flare at 26/1540 UTC.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	25	30	30	30
Very Active	R3 to R5 X Class	No	5	5	5	5

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (10MeV) measured at GOES-16 is expected to remain at Background levels, although the risk of an S1 event increases slightly later in the forecast period, as AR2975 and AR2976 transfer to the western hemisphere.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	2	2	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux as observed by GOES-16 at GEO is currently at Background but likely to rise day 1 (27th) due to the arrival of the fast wind of CH69. This is further complicated by a likely CME arrival either late 27th or early 28th, likely causing a drop out to observed flux levels when it arrives. Despite this, periods of Moderate to High are possible on the 27th, and returning once any CME affects subside.
The associated 24 hour fluence is expected to rise from any moderate to high flux from the fast wind of CH69, although likely staying below the Active threshold, due to the potential CME arrival. However there is a slight chance that Active fluence does develop, with some uncertainty around the strength and timing of the CME. REFM is currently giving good guidance up to T+24, with fluence forecast to remain below the threshold. However beyond this period, any fast wind influence is likely to increase fluence above REFM values with a chance of reaching Active levels by the end of the period.

GEO Electron Environment	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	5	10	20	30
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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